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DISSEMINATING TECHNOLOGICAL INFORMATION
ON REMOTE SENSING TO POTENTIAL USERS*

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ABSTRACT

The Laboratory for Applications of Remote Sensing has developed materials and programs which range from short tutorial brochures to post-doctoral research programs which may span several years. To organize both the content and the instructional techniques, a matrix of instructional materials has been conceptualized. Each row in the matrix represents a subject area in remote sensing and each column in the matrix represents a different type media or instructional strategy.

How can technological information be quickly disseminated to potential users in a rapidly expanding field of research? Historically, there has been a significant time lag between technological breakthroughs and the widespread use of new technology. The Laboratory for Applications of Remote Sensing (LARS) at Purdue University is faced with this problem.

LARS is a research facility within the structure of Purdue University. The overall objective of the laboratory is to attack, in an interdisciplinary environment, specific remote sensing problems of current national and world interest in the area of earth resources. A multidisciplinary staff of over 100 professionals and graduate students from 22 departments within the university conducts research, develops computer analysis techniques, explores applications and trains people in the area of numerically oriented remote sensing systems.

Currently one of the major efforts at LARS is to share an understanding of the technology with those addressing natural resources and environmental questions. To train users, a Technology Transfer program area has been established. The staff who handle these educational functions includes experienced educators, training specialists, and instructional developers. The team is responsible for developing educational materials and conducting training programs to transfer remote sensing technology from the research arena to the applications arena.

Since remote sensing is a rapidly expanding field of research, there is a growing need to provide training for graduate and undergraduate students as well as the continuing education of scientists, engineers and users of the associated technology. The scientists and engineers range from those untrained in remote sensing to those already in the field but needing to expand their specialized knowledge and learn about new technological developments. The potential users of the technology are associated with federal, state, city and county agencies as well as business and industry.

Rapid technological developments in remote sensing and the broadening of its use have created a need for educational materials that are relevant and

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up-to-date. Since remote sensing is an interdisciplinary field, the scope of the content to be disseminated is very broad. It ranges from information about the electromagnetic spectrum (physics), numerical analysis techniques (mathematics) and spectral characteristics of vegetation (biology) to specific applications of the technology in fields such as geology, geography, urban planning and agriculture. The types of instructional strategies developed must be diverse in both format and content to meet this need. LARS has developed materials and programs which range from short tutorial brochures to post-doctoral research programs which may span several years. To organize both the content and the instructional techniques, a matrix of instructional materials has been conceptualized (see Figure 1 and References 1 and 2). Each row in the matrix represents a subject area in remote sensing and each column in the matrix represents a different type media or instructional strategy.

The simplest material in the matrix is the FOCUS series which treats basic ideas important in remote sensing. Each pamphlet in the series presents a single concept through several paragraphs of concisely written text supported by illustrations. Care is taken to minimize the use of technical terms in the description and to include definitions where confusion might occur. The two-page pamphlet format is useful because of its portability and flexibility. The pamphlets format also makes them relatively inexpensive to produce and yet attractive to the potential reader. A student typically spends 5 to 10 minutes on these materials.

A very popular and widely used type of instructional materials is the minicourse series. (3) The minicourse series is modularized so that after completing two introductory units, the student may study any of seventeen others presently in the series. Each minicourse includes a set of slides, an audio tape and a printed study guide, and typically requires from 45 to 70 minutes to complete. The student controls the rate and intensity of his study. The student is actively involved in manipulating materials associated with remote sensing, completing exercises and solving problems in the study guide.

A third format involves motion with sound in the form of videotapes. The videotapes produced for LARS "capture" a subject matter specialist discussing an area of remote sensing. Viewing notes have been developed for use with the locally-produced videotapes. Each videotape runs about thirty minutes. For an extended topic, such as pattern recognition, there is a series of videotapes.

Simulation exercises have been designed to lead the student through the professional thought and decision-making processes typical of those required by remote sensing analysts. These units, requiring 3 to 5 hours to complete, illustrate and explain the rationale, decisions and procedures of the professional remote sensing analyst.

Case studies require the student to make his own decisions, specify analysis techniques and interpret analysis results. The case studies usually involve the student using hardware, such as stereoscopic viewers, computers, etc. Intermediate results can be reviewed with a tutor or instructor. Case studies usually require on the order of 10-40 hours to complete.

Using these materials from the matrix, individual training programs can be synthesized. Typically a larger number of units is selected from the left columns with fewer units being selected as the student moves to the right on the matrix. An instructional program can be designed to meet the needs and interests of each individual. When possible, students with the same needs are brought together in small groups of six to eight so that a coordinator of training can encourage group interaction and facilitate discussion of newly learned concepts, principles and procedures. The length of these training programs may vary from half-a-day to several months. Examples of the training programs at LARS include an educational package to train people to use LARSYS (a computer software system), a one-week monthly short course and a visiting scientist program.

An educational package was developed to train people to analyze remotely sensed data using LARSYS, a computer software system. (4) LARSYS software is available through COSMIC or an organization can access LARSYS through the LARS Remote Terminal System. The word "system" is used instead of "network" since

considerable support is provided beyond the basic hardware/software capability. The additional support includes training materials, educational services, extensive software documentation and consultants. The training materials were designed for independent study since organizations getting started in the analysis of remotely sensed data usually have only two or three people making initial use of LARSYS. As their experience and skills improve, other personnel can be trained by them. The individuals usually start at different times and progress at different rates depending upon their background and other duties. Essential to the effective use of the educational package is a tutor with computer analysis experience. Therefore, two people from an organization usually come to LARS for training and they in turn train other people within their organization who train additional staff.

A variety of media and instructional strategies is used in the educational package. The first unit is a programmed textbook. An audio tape, a display book and student notes accompany the second unit. Unit III, a demonstration of a remote terminal, requires an instructor who is familiar with the computer hardware. An outline and suggestions to the instructor are provided along with a set of student notes. During Unit IV, the student gets hands-on experience with the terminal and then completes simple analysis problems in the following unit. The initial training, which requires about 15 to 17 student hours, prepares the student to tackle one of several case studies requiring 40 to 50 hours. These case studies provide a detailed explanation of the philosophy of the analysis methods with an example that parallels the analysis he is to do.

A very effective instructional strategy for training individuals from business, industry and government has proven to be a week-long short course. (5) The short course which is limited to eight to fifteen participants, combines many of the instructional materials already described. For example, the fundamentals of remote sensing are presented by the minicourse series with each participant determining the units which he studies. Videotapes also allow content to be presented by an expert in the field and at the same time free him from having to repeat the same basic presentation each time the course is offered. However, during the short course the expert is usually available for questions and discussions following the videotape.

About one fourth of the short course is devoted to a simulation in which the participants learn the basics of computer-oriented techniques used to analyze remotely sensed data. No prior computer experience is required to gain an understanding of the processes involved. The simulation presents the process in a step-wise sequence and allows the participants to actually make the same decisions an analyst has to make when analyzing remotely sensed data. Computer output is supplied and the results of the participant's decisions are discussed with the teaching staff.

To enable scientists to study remote sensing in depth at the Laboratory for Applications of Remote Sensing, a Visiting Scientist Program has been established. This program provides an opportunity for personalized study at the laboratory during a period of residence which may vary from several days to many months. The instructional portion of the program incorporates media and materials selected from the matrix. In addition, the participants can interact on a one-to-one basis with remote sensing specialists at LARS. The experience is a "reverse consulting" arrangement. Rather than have one consultant come to the person's home institution, the person goes to LARS and has a variety of "experts" available to him along with the supporting hardware (computer, digital display, etc.). The cost of the program is comparable to a daily consulting fee for the first few days of the visit with the daily cost decreasing as the length of the visit increases.

Evaluation is continuous during the development and use of instructional materials at LARS. The materials are used with individual students and their reaction to the material is solicited. On the basis of this feedback, the materials are revised and tested with additional individuals. The materials are then ready for use "in the field" with large groups of students and away from the direct control of the developers. Similar student reaction data is gathered. Usually only minor modifications are necessary at this point in the development sequence. Then the materials are ready for dissemination and use.

When there are changes in either the hardware or software, the materials are updated.

SUMMARY

By working with individuals or small groups, training coordinators at LARS are able to establish objectives for each "student" and to structure the learning program to begin where he is and continue from that point to meet each individual's needs and interests. The Technology Transfer staff has found that systematically designing instructional materials and activities using the matrix as an organizer has proven to be very effective in meeting the needs of students, scientists and users in this rapidly developing technology.

REFERENCES

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MATRIX OF INSTRUCTIONAL MATERIALS IN REMOTE SENSING

Background Needed: **Extensive
*Moderate
None

TOPICS			FOCUS (10-20 minutes)	Minicourses (45-75 minutes)	Videotapes (30-60 minutes)	Simulations (3-4 hours)	Case Studies (20-40 hours)
			INSTRUCTIONAL MATERIALS				
		Introductory, Basic Concepts	F7	M1, E1	V1		
Physical Basis		Electromagnetic Spectrum		M2			
		Atmospheric Effects		M2			
		Spectral Reflectance	F10, F14	M2, M3*, M4*	V9, V10*, V11*		
		Emittance		M2	V11*		
Data Collection	Instruments	Photographic		M9*	V2, V9, V10*		
		Multispectral Scanners	F1	M8*	V2, V9, V10*		F6**, E7**
		Radar		M10*			
		Spectrometers			V12**		
	Systems	Mission Planning		M5*	V3**		
		Airborne			V2		E6**
		Satellite	F8, F12	M6*, M7*	V2		E7**
Data Analysis Techniques	Images	Photography		M13*			
		Scanner Images	F9, F12	M15*			
		Radar Images		M14*			
	Computer-Aided	Pattern Recognition	F2, F3, F5, F13	E1, M11*, M12**	V4, V5*, V6**, V7**, V8**	E2*	E6**, E7**
		LARSYS	F6, F11	E4*, E5**	V7**, V8**	E2*, E3*	E6**, E7**
Applications		Agronomy	F4, F10	M18*			E6**
		Forestry		M16*		S1**	E7**
		Geography			V13		E7**
		Geology		M17*			
		Land Use				S2**	E7**
		Hydrology		M19*			E7**

F=Focus Series M=Minicourse Series V=Videotape E=LARSYS Educational Package S=Simulations

Figure 1